

*Photographic Search for a Planet beyond the Orbit of Neptune.*

By Isaac Roberts, F.R.S.

The hypothesis that one or more planets exist beyond the orbit of *Neptune* has been long entertained by astronomers, and Professor Forbes, in a remarkable paper on "Comets and ultra-Neptunian Planets," which he read before the Royal Society of Edinburgh at the beginning of the year 1880, predicted with considerable confidence that one or two such planets exist, and in the paper referred to he gave very fully his reasons.

The prediction was based upon the recorded positions of the aphelia of a number of comets. He said,\* "That there could be no longer a doubt but that two planets revolve in orbits external to that of *Neptune*, one about 100 times, the other about 300 times the distance of the Earth from the Sun."

In 1887, November, I wrote to Professor Forbes to ask him if he had further considered the hypothesis concerning the supposed planets, and that I was prepared to make a search for them by photographic methods. In his reply he stated that the present position of one of the hypothetical planets is  $11^{\text{h}} 48^{\text{m}}$  R.A. and  $3^{\circ}$  N. Declination, and he believed that a range of  $5^{\circ}$  each way in R.A. and of  $2^{\circ}$  or  $3^{\circ}$  in Declination ought to find the planet if it is there. The motion of the planet he computed at one degree in 2.96 years.

I thereupon commenced the search, but soon found that the climate of Maghull was so unfavourable for celestial photographic work of this character that my task was nearly hopeless; but since the removal of my observatory to Crowborough I resumed the search under conditions sufficiently favourable to complete the work, which was conducted on the following plan:—

A chart was made of the region indicated by Professor Forbes between R.A.  $11^{\text{h}} 24^{\text{m}}$  and R.A.  $12^{\text{h}} 12^{\text{m}}$  with Declination  $0^{\circ} 0'$  to  $6^{\circ} 0'$  North. This region was covered by eighteen photographic plates, each of more than four square degrees in area, and allowed of sufficient overlap to show a number of the same stars on two or more contiguous plates. Two sets of photo-plates of the region were taken with an interval of not less than seven days between the exposures, which were of ninety minutes duration, and the dual photographs were subsequently compared three times over by superposition, in order to see if any star appeared on one plate which was not on the other, or to see if change in the position of any star had taken place in the interval between the dual exposures. In this way the whole of the plates covering the region were very carefully examined, and it now only remains for me to report that no planet of greater brightness than a star of the 15th magnitude

\* *Memoir*, p. 3.

exists on the sky area herein indicated, nor is there on the plates any abnormal appearance to which it is necessary here to draw special attention. It is a region where the stars are not exceptionally numerous, and they are mostly faint.

*Crowborough Hill, Sussex:*  
1892 April 12.

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*Photographs of the Region of the "Crab" Nebula, 1 M Tauri.*  
By Isaac Roberts, F.R.S.

Two photographs of the region of the nebula 1 M Tauri, R.A.  $5^h 29^m$ , Dec.  $21^\circ 57'$  N., are now presented, which have been enlarged from a negative taken with the 20-inch reflector on 1892, February 2, and exposure of three hours. One of the enlarged photographs is to the scale of one centimetre to four minutes of arc, and covers a sky area of ninety-two minutes of arc in Right Ascension by 112 minutes in Declination. The other photograph is enlarged to the scale of one centimetre to forty seconds of arc, and covers an area of nine minutes in diameter. The nebula measures 340 seconds of arc in extreme length by 260 seconds in breadth, and I counted sixteen stars involved in it.

The nebula is not symmetrical in form, and has a faint, undefined, boldly indented margin, with a large projecting limb on the south preceding side. It is oval in general outline, with the major axis in south following and north preceding direction, and on the north following side is a large deep embayment with little nebulosity in it, and there is also a smaller bay, but with nebulosity partly filling it. The negative shows dense massive cloudiness in parts of the nebula, with fainter areas between them, but they are too dense to print so as to be visible in detail on the enlargements.

I have not seen any drawing of this nebula that conveys even approximately an idea of its form as it is shown on the photograph, and there is no indication of the filamentous projections that are shown on some drawings, and which, if they had a real existence, would undoubtedly be shown.

The stars in the region of the nebula are very numerous, and when viewed on the negative the eye readily arranges them into festoons and wreaths of many patterns, but an enlargement, even to three and a half times, in great measure modifies this effect of perspective, which a larger magnifying power would dissipate.

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